SOIL STRUCTURE

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Definition

- Soil structure is arrangement of individual soil particles into a pattern
- Soil structure is a compilation of tiny, medium and big soil pores in a pattern

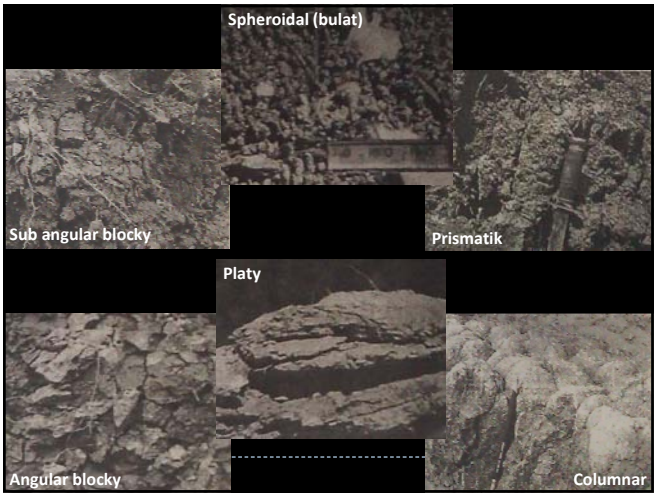
Soil structure wasn't plant growth factor but affect to all growth plant factors, such as water input, aeration, nutrition availability, microbial activity, root pressure, etc.

Soil Structure Classification

Classification based on shape:

a. Simple Structure: natural crack area not present or not clear
   - Single granule structure: soil particles are loose e.g. sand and silt
   - Compact structure : look like single granule structure but solid/compact

b. Bundle structure: natural crack area was clear
   - Platy structure
   - Prismatic structure
   - Columnar structure
   - Angular blocky structure
   - Sub angular blocky structure
   - Granular structure
   - Crumb structure

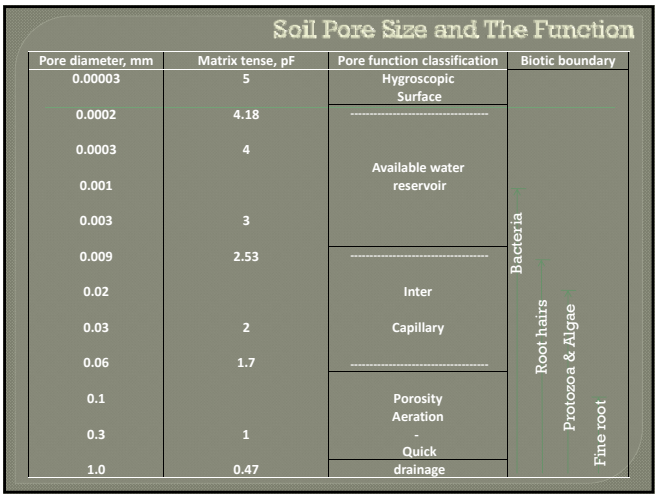


Classification based on aggregate size:

Size	Platy	Prismatic	Blocky	Crumb, Granular
Very smooth	< 1 mm	< 10 mm	< 5 mm	< 1 mm
Smooth	1-2mm	10-20 mm	5-10 mm	1-2 mm
Medium	2-5 mm	20-50 mm	10-20 mm	2-5 mm
Coarse	5-10 mm	50-100 mm	20-50 mm	5-10 mm
Very Coarse	> 10 mm	> 100 mm	> 50 mm	> 10 mm

Classification based on pores size

Since, the plant root and microbial life in soil pore space, so soil structure classification based on pores is quite important. Beside that pores linkable with aeration- drainage, inter capillary and water reservoir.



Classification based on Aggregate Steadiness

Aggregate steadiness is the capability of soil aggregate defending to rain drop impact or water drowning.

Aggregate steadiness measurement can be done with wet and dry sieving method (quantitative) or drowning method into water or alcohol (qualitative)

Aggregate steadiness value

Aggregate steadiness	Harkat
Very Steady	> 200
More Steady	80 – 200
Steady	61 – 80
Almost Steady	50 – 60
Less Steady	40 – 50
Unsteady	< 40

Factors affecting aggregation

1. Clay and Exchangeable Ion

- Clay helps aggregate formation works as glue, the ability to grow and shrink, as slight membrane covering the small aggregate.
- Cation like Ca, Mg, and K are plucking the clay, but H and Na can separating it.

2. Inorganic glue

- Sesquioxide form the irreversible colloid and slowly reversible colloid made the water resistant soil, e.g. latosol (alfisols) Calcium carbonate can also be the glue

3. Plant and plant residue

- Plant helps soil aggregation by the root excretion, root force, CO_2 from the respiration, root hair, water losses by root, upper part of the plant protect the soil from temperature change, moisture, and rain drop. e
- Plant residue, root or biomass become an organic matter (OM) that lead to aggregation and biomass protect the soil from temperature change and rain drop

4. Organic Matter and Glue

- Organic matter provide aggregation and soil structure steadiness, because form irreversible colloid and slow irreversible that act as glue.
- Organic matter can be used as soil conditioner that is a long chain carbon compound with clay exchange complex, the examples of soil conditioner are PVAc (polyvinyl acetat), PVA (polyvinyl alcohol), PAA (polyacrylic acid) dan PAM (polyacrylic amide)

5. Microbia

- Clay plucking commonly not suitable to form a steady aggregate
- Algae, fungi, actinomycetes dan bacteri form a life matter that defend more effective soil particle group.

6. Animal

- Several experiments explained that almost original humus is result of small metabolic from worm, termites, nematode, bugs, etc.
- It's guess, worm can produce an steady water aggregate same with his weight in a day, so if there more worms population the better aggregate of soil will be.

7. Air

- Physically air role in aggregate forming connected with water tight and air booming result from soil wetness
- Chemically, air helps Fe and Al colloids precipitation, the CO_2 in soil will bound Ca that role as aggregation glue.
- Biologically air in soil needed to root and bacteria respiration.

8. Temperature

- The impact of temperature commonly indirect
- Physically temperature affected the structure connected to air movement, freezing, and melting.
- Chemically, temperature affected the reaction speed that linkable to organic matter break down and mineral decay
- Biologically, temperature affected to plant and microbia
- Temperature as the component of climate that mostly affected to soil structure

9. Pressure

- Pressure affected soil structure through shrink and swell, root pressure, freezing, agricultural machines, and the weight of soil itself.

10. Water

Water ruled in soil structure forming by

- Swollen and furrow
- Table tight
- Rapid cooling and freezing
- Water is requirement for plant and microbial life
- Water as climate factor

Soil Structure that suitable for plant

From agricultural sector the best soil structure is structure that give highest yield. The quality of structure can describe as porosity, aggregation, permeability, and cohesion.

Porosity

Wide pore provide aeration, infiltration, and drainage, medium pore give easy access to water transport, small pore can be used as water reservoir that can be used for plant.

Aggregation

Aggregation must be arrange with the distribution of balanced pore size and have a high steady aggregate. Aggregate have a vertical axis same or higher, the dull end (angular), sand size or pebbles and water resistant aggregate.

Permeability

The best permeability is structure condition that can grew the plant, high infiltration capacity, medium percolation capacity, and enough air exchange.

Cohesion

Soil change due to soil moisture, the good cohesion is structure conditions that guarantee the moisture rate that need by plant in a long time period. Soil is brittle but not to loose, soil chunks has a high cohesion to soil damaged by water.

Measure Soil Structure

Soil Structure measurement can be done both qualitative or quantitative

Qualitative

Make a soil profile then look the shape of aggregate, size, degree, aggregate steadiness can be tested by take the soil chunks then submerged in water and alcohol, pour the water in the oil surface so the permeability can be measured, with penetrometer soil cohesion can be measured.

Quantitative

Space distribution can be determined by saturating the sample with water then remove the increasing tight,

Total porosity counted from weight volume measurement and soil weight.

Aggregate distribution determined by dry sieving.

Aggregate steadiness measure by wet sieving

Soil permeability measured with permeameter, wrinkle degree measured by absolute weight volume dry and wet soil

Managing Soil Structure

Goal

- From plant growth sector the goal of managing soil structure is to maintaining the optimum condition of porosity, aggregate, and permeability.
- From soil conservation sector, the goal of managing soil structure is to decrease the damage by water and air, increase the infiltration and percolation capacity so run off and erosion is minimized.

Base step

- To reach the goal we need to manage the moisture aeration, soil consistency, deeper the productive soil, and avoid the erosion.

Method

Method for getting the suitable soil structure such as by proper land use, increase plant growth, adding the organic matter, fertilizing, soil processing, subsoil recovery, mulching, drainage recovery, irrigation, cover from rain drop, and the adding of soil conditioner. Soil structure managing to 20-30cm deep must be rich of non-capillary pore, water resistant aggregate, can manage the waer over load, have pore space for air to get in.